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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/633,824	08/04/2003	Donald He	IR-2014 (2-2573)	5279

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OSTERLENK, FABER, GERB & SOFFEN
1180 Avenue of the Americas
New York, NY 10036-8403

EXAMINER

SEFER, AHMED N

ART UNIT PAPER NUMBER

2826

DATE MAILED: 03/18/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary

Application No.

10/633,824

Applicant(s)

HE ET AL.

Examiner

A. Sefer

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 January 2005.
 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-10 and 18-22 is/are pending in the application.
 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
 5) ☐ Claim(s) _____ is/are allowed.
 6) ☒ Claim(s) 1-10 and 18-22 is/are rejected.
 7) ☐ Claim(s) _____ is/are objected to.
 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some * c) ☐ None of:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
 Paper No(s)/Mail Date 1/2005.
 4) ☐ Interview Summary (PTO-413)
 Paper No(s)/Mail Date. _____.
 5) ☐ Notice of Informal Patent Application (PTO-152)
 6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. The amendment filed January 3, 2005 has been entered and claims 11-17 have been cancelled.
2. The reply filed on January 3, 2005 is not fully responsive to the prior Office Action because of the following omission(s) or matter(s): The objections to the specification and the drawings as well as the rejection of claim 7 under 35 U.S.C. 112, first paragraph have not been addressed.

Allowable Subject Matter

3. The indicated allowability is withdrawn in view of the newly discovered reference(s) to Numazawa et al. ("Numazawa") US PG-Pub 2005/0037579. Rejections based on the newly cited reference(s) follow.

Specification

4. Claims 1, 6, 7, 10, 18 and 22 objected to because of the following informalities: Since both the switching device and the schottky device include trench(s), it is suggested that the limitations that recite trenches are rewritten to distinguish one trench from the other. Appropriate correction is required.

Drawings

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: Reference numerals 42, 54 and 58 are not shown in fig. 2. Corrected drawing sheets in compliance with 37 CFR

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1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: Reference numeral 51 shown in fig. 2 is not mentioned in the description. Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

7. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it

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pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

8. Claim 7 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The claim contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Specifically, the limitation “said schottky barriers extends over said sidewall of said trenches” is supported neither by the figs. nor by the written description (see page 7, first par.) which describes the schottky barrier extending to the sidewall of mesa 36.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 1-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Grover et al. (“Grover”) US PG-Pub 2003/0022474 in view of Numazawa.

Grover discloses (figs. 1-2 and par. 0065) a die having formed therein a semiconductor switching device or a MOSFET (as in claim 3) and a schottky device, said semiconductor switching device including a plurality of trenches 20 each including a pair of opposing sidewalls

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and a bottom wall and each extending from a top surface of said die to a drift region 14 in the body of said die, channel regions 12 of a first conductivity type formed in said die and disposed adjacent the sidewalls of said trenches, a gate insulation layer 17 disposed on each sidewall of a trench adjacent a respective channel region, conductive gate material 11 contained within said trenches and insulated from said channel regions by said gate insulation layers, and regions 15 of a second conductivity type opposite to the conductivity type of said channel region each disposed at a sidewall of a respective trench and each extending from the top surface of said die to a respective channel region; said schottky device including a schottky barrier 80 comprising $\text{TiSi}(2)$ (as in claim 4) disposed over and in schottky contact with a portion of the top surface of said die or disposed over a major surface of a mesa formed in said die (as in claim 5) and extending over sidewalls of said trenches (as in claim 7); and a first contact 33a in contact with said schottky barrier and said regions of said second conductivity type, but lacks anticipation of a termination structure.

Numazawa discloses in figs. 1-3 a semiconductor switching device including a termination structure, said termination structure being comprised of a depression formed in said die to a depth below that of a channel region 8, a first insulation layer 5 formed over major surfaces of said depression, a conductive layer 6 formed over said insulation layer, a second insulation layer 7/10 formed over said conductive layer, and a termination contact 12B formed over said second insulation layer, wherein said termination contact is in electrical contact with said conductive layer through said second insulation layer (through hole 11B).

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Therefore, it would have been obvious to one skilled in the art at the time the invention was made to incorporate Numazawa's teachings with Grover's device since that would increase the reliability of the device as taught by Numazawa.

As for claim 2, Grover discloses a second contact 34 in contact with a major surface of said die opposite said first contact.

As for claim 6, Grover discloses in figs. 1 and 2 a schottky device comprising a mesa having a trench 20 formed on either side thereof, each trench having an insulation layer 17 formed on its side walls and bottom and containing a conductive material 11s.

As for claims 8 and 9, Grover discloses in figs. 1 and 2 high conductivity region 13 of the same conductivity as said channel region located at the bottom of a recess in said die (as in claim 9) and disposed between each pair of said regions of said second conductivity type 15 and in contact with said first contact 33a.

11. Claims 18-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Grover in view of Numazawa.

Grover discloses (figs. 1-2 and par. 0065) a semiconductor device comprising: a die having formed therein a schottky device and a Mos-gated switching device or a MOSFET (as in claim 19), said schottky device including a plurality of schottky regions (unnumbered) including a schottky barrier 80 disposed over a major surface of a mesa formed in said die (as in claim 21) and comprising TiSi (2) (as in claim 20) formed on a surface of said die, and said Mos-gated switching device including a channel region and a plurality of gate structures, each structure including a trench 20 having an insulation layer 17 formed on its sidewalls and containing a

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conductive 11; wherein said gate structures are formed in groups and spaced from one another by a schottky region, but lacks anticipation of a termination structure.

Numazawa discloses in figs. 1-3 a semiconductor switching device including a termination structure, said termination structure being comprised of a depression formed in said die to a depth below that of a channel region 8, a first insulation layer 5 formed over major surfaces of said depression, a conductive layer 6 formed over said insulation layer, a second insulation layer 7/10 formed over said conductive layer, and a termination contact 12B formed over said second insulation layer, wherein said termination contact is in electrical contact with said conductive layer through said second insulation layer (through hole 11B).

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to incorporate Numazawa's teachings with Grover's device since that would increase the reliability of the device as taught by Numazawa.

As for claim 22, Grover discloses in figs. 1 and 2 a schottky region comprising a mesa having a trench 20 formed on either side thereof, each trench having an insulation layer 17 formed on its side walls and bottom and containing a conductive material 11s.

12. Claims 18, 19 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hsieh et al. ("Hsieh") US PG-Pub 2003/0207538 in view of Numazawa.

Hsieh discloses (see fig. 5 and par. 0049) a semiconductor device comprising: a die having formed therein a schottky device 222 and a Mos-gated switching device 220 or a MOSFET (as in claim 19), said schottky device including a plurality of schottky regions formed on a surface of said die, and said Mos-gated switching device including a channel region a plurality of gate structures, each structure including a trench having an insulation layer 206

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formed on its sidewalls and containing a conductive 210; wherein said gate structures are formed in groups and spaced from one another by a schottky region, but lacks anticipation of a termination structure.

Numazawa discloses in figs. 1-3 a semiconductor switching device including a termination structure, said termination structure being comprised of a depression formed in said die to a depth below that of a channel region 8, a first insulation layer 5 formed over major surfaces of said depression, a conductive layer 6 formed over said insulation layer, a second insulation layer 7/10 formed over said conductive layer, and a termination contact 12B formed over said second insulation layer, wherein said termination contact is in electrical contact with said conductive layer through said second insulation layer (through hole 11B).

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to incorporate Numazawa's teachings with Hashieh's device since that would increase the reliability of the device as taught by Numazawa.

As for claim 22, Hashieh discloses a schottky region comprising a mesa having a trench formed on either side thereof, each trench having an insulation layer 206 formed on its side walls and bottom and containing a conductive material 210.

13. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Grover in view of Numazawa as applied to claim 1 above, and further in view of Ngo et al. ("Ngo") USPN 4,903,189.

The combined references disclose the device structure as recited in the claim, but does not specifically disclose a thick oxide layer at a bottom of each trench.

Ngo discloses (see col. 13, lines 50-57 and col. 14, lines 19-35) an advantage of including a thick oxide layer at a bottom of a trench.

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to incorporate Ngo's teachings since that would increase the breakdown voltage as taught by Ngo.

14. Claims 1-3, 5-7 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hshieh in view of Thapar US PG-Pub 2004/0119103 and Numazawa.

Hshieh discloses in fig. 5 a die having formed therein a semiconductor switching device 220 or a MOSFET (as in claim 3) and a schottky device 222, said semiconductor switching device including a plurality of trenches 210 each including a pair of opposing sidewalls and a bottom wall and each extending from a top surface of said die to a drift region 202 in the body of said die, channel regions of a first conductivity type formed in said die and disposed adjacent the sidewalls of said trenches, a gate insulation layer 206 disposed on each sidewall of a trench adjacent a respective channel region, conductive gate material 210 contained within said trenches and insulated from said channel regions by said gate insulation layers, and regions 204 of a second conductivity type opposite to the conductivity type of said channel region each disposed at a sidewall of a respective trench and each extending from the top surface of said die to a respective channel region; a first contact 216 in contact with said regions of said second conductivity type, but lacks anticipation of a termination structure and a schottky barrier disposed over and in schottky contact with a portion of the top surface of said die.

Thapar discloses in fig. 4 a schottky device comprising a schottky barrier 50 disposed over or disposed over a major surface of a mesa formed in a die (as in claim 5) and in schottky

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contact with a portion of a top surface of a die; wherein said schottky barrier extends over sidewalls of a trench 60 (as in claim 7).

Numazawa discloses in figs. 1-3 a semiconductor switching device including a termination structure, said termination structure being comprised of a depression formed in said die to a depth below that of a channel region 8, a first insulation layer 5 formed over major surfaces of said depression, a conductive layer 6 formed over said insulation layer, a second insulation layer 7/10 formed over said conductive layer, and a termination contact 12B formed over said second insulation layer, wherein said termination contact is in electrical contact with said conductive layer through said second insulation layer (through hole 11B).

Therefore, it would have been obvious to one skilled in the art at the time the invention was made to incorporate Thapar's teachings with Hshieh's device since that would avert a snapback of the device as taught by Thapar. It would have been obvious to one skilled in the art at the time the invention was made to incorporate Numazawa's teachings since that would increase the reliability of the device as taught by Numazawa.

As for claim 2, Hshieh discloses a second contact 218 with a major surface of said die opposite to said first contact.

As for claim 6, Thapar discloses a schottky device comprising a mesa having a trench formed on either side thereof, each trench having an insulation layer formed on its sidewall and bottom and containing conductive material.

As for claim 10, Hshieh discloses a thick oxide layer 206 at the bottom of each trench.

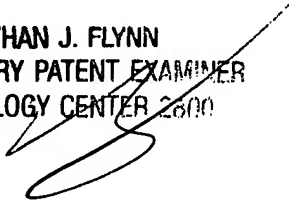
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Any inquiry concerning this communication or earlier communications from the examiner should be directed to A. Sefer whose telephone number is (571) 272-1921.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800



ANS
March 10, 2005